# INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

## Part I: Background Information

| Title: | Information Category: |
|---|---|
| Actual waste testing with a single disk SpinTek rotary microfilter | ☐ Abstract ☐ Journal Article ☐ Summary<br>☐ Internet ☒ Visual Aid ☐ Software<br>☐ Full Paper ☐ Report ☒ Other Powerpoint |
| Publish to OSTI? ☒ Yes ☐ No | |

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Purpose of Document: Presentation at ACS National meeting

## Part II: External/Public Presentation Information

Conference Name: ACS 239th National Meeting

Sponsoring Organization(s): American Chemical Society

Date of Conference: 03/25/2010 Conference Location: San Francisco

Will Material be Handed Out? ☐ Yes ☒ No Will Information be Published? ☐ Yes ☒ No *(If Yes, attach copy of Conference format instructions/guidance.)*

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| Document Release Criteria in TFC-ENG-DESIGN-C-25 completed? (Attach checklist) | ☐ | ☒ | |
| If product contains pictures, safety review completed? | ☒ | ☐ | |

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| Responsible Manager | WRPS | 3/3/10 | Gary M Seidel 3/3/10 |
| Other: | | | |

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# INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

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| WRPS Office of Chief Counsel | ☑ | ☐ | Carrie Meyer |
| DOE – ORP Public Affairs/Communications | ☑ | ☐ | |
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Comments:

SpinTek is a trademark of SpinTek Filtration, Inc., Los Angeles, CA.

APPROVED FOR RELEASE OFFICIAL DOCUMENT Date 03/08/2010

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LAB-RPT-10-00004
Revision 0

# Actual waste testing with a single disk SpinTek rotary microfilter

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800

washington**river**
**protection***solutions*

**P.O. Box 850**
**Richland, Washington 99352**

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# Actual waste testing with a single disk SpinTek rotary microfilter

Dr. Heinz J. Huber
Washington River Protection Solutions

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washington**river**
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**P.O. Box 850**
**Richland, Washington**



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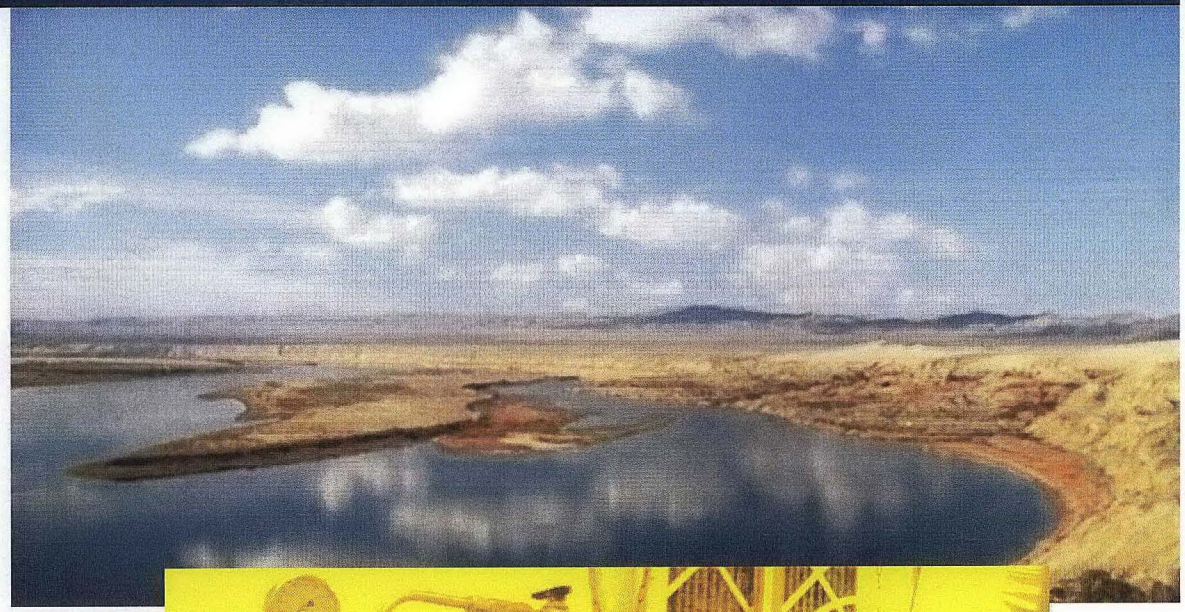
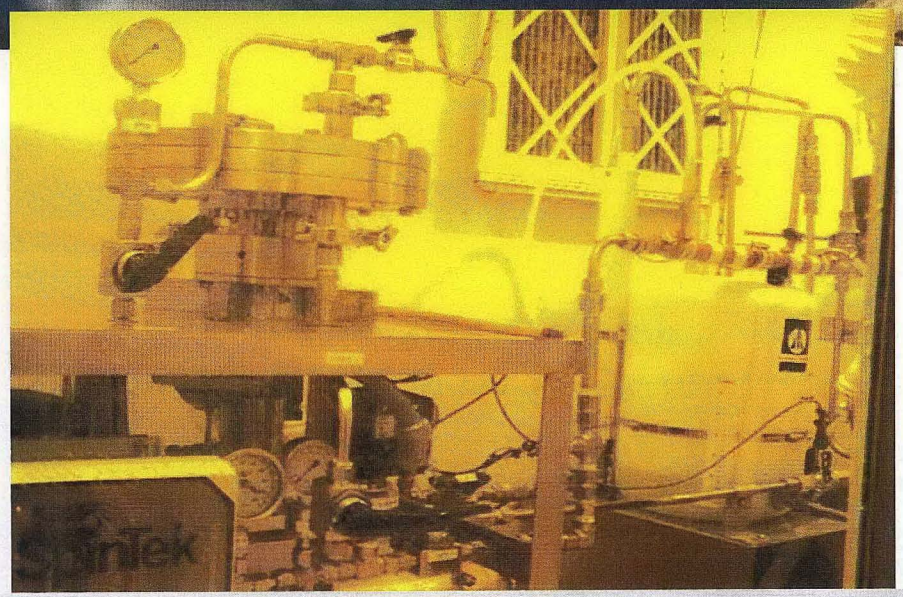
# Actual waste testing with a single disk SpinTek rotary microfilter






Dr. Heinz J. Huber, WRPS

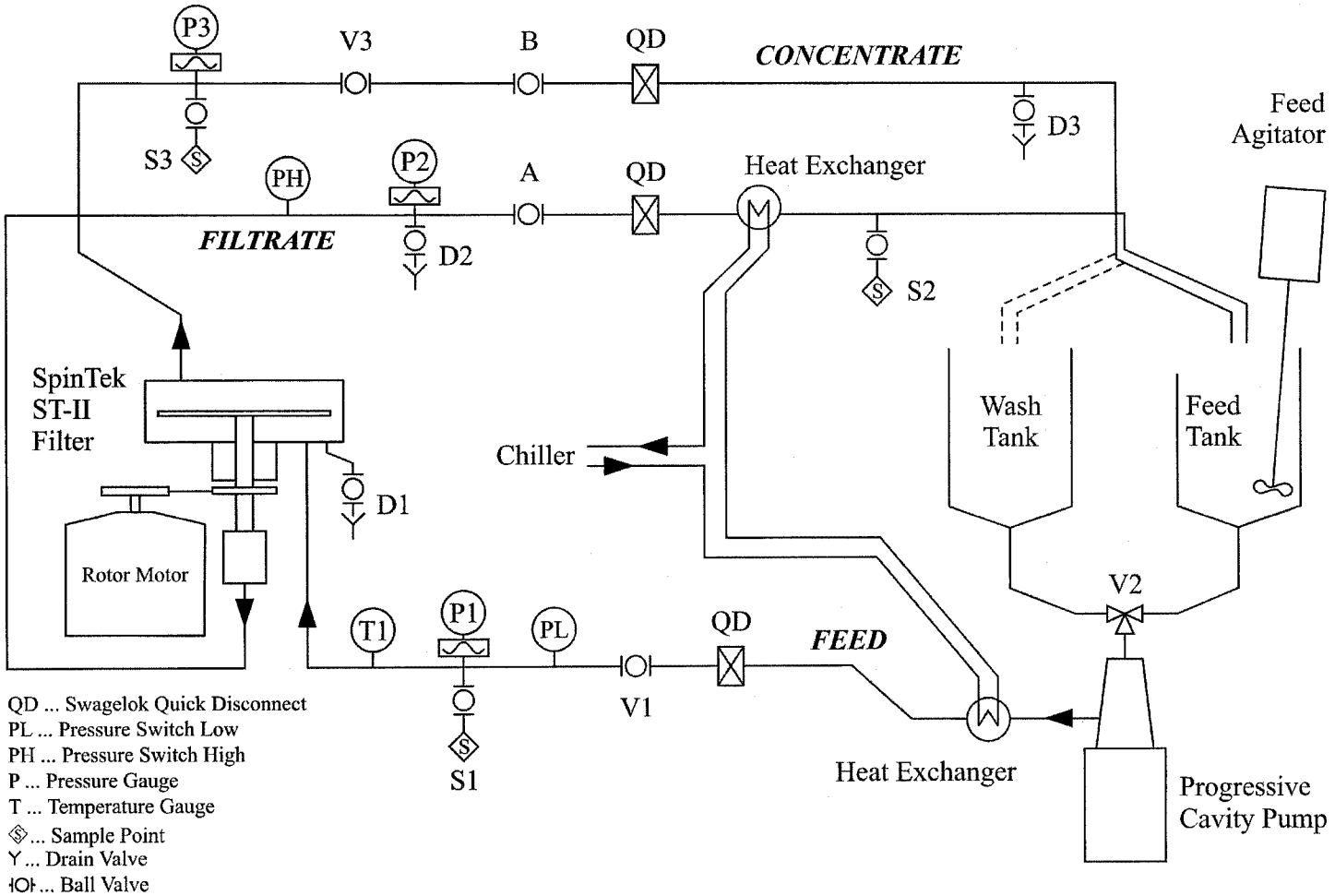
Presentation at
ACS 239th National meeting
March 25, 2010



LAB-RPT-10-00004

# Actual waste testing using SpinTek microfilter

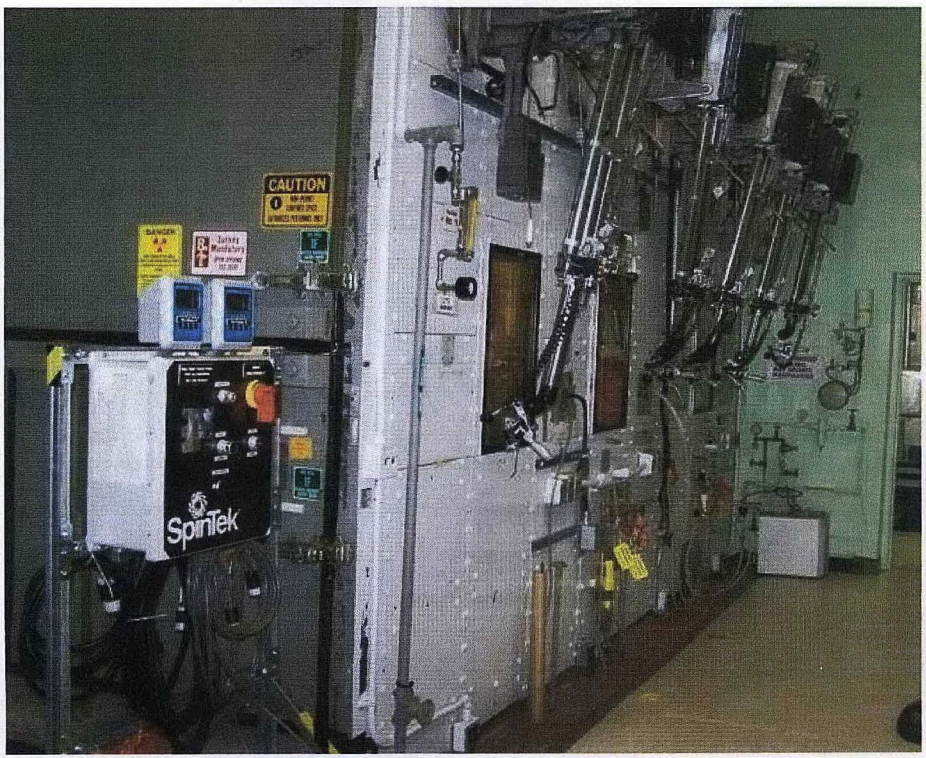
## Process Diagram of SpinTek microfilter in 1-F hot cell

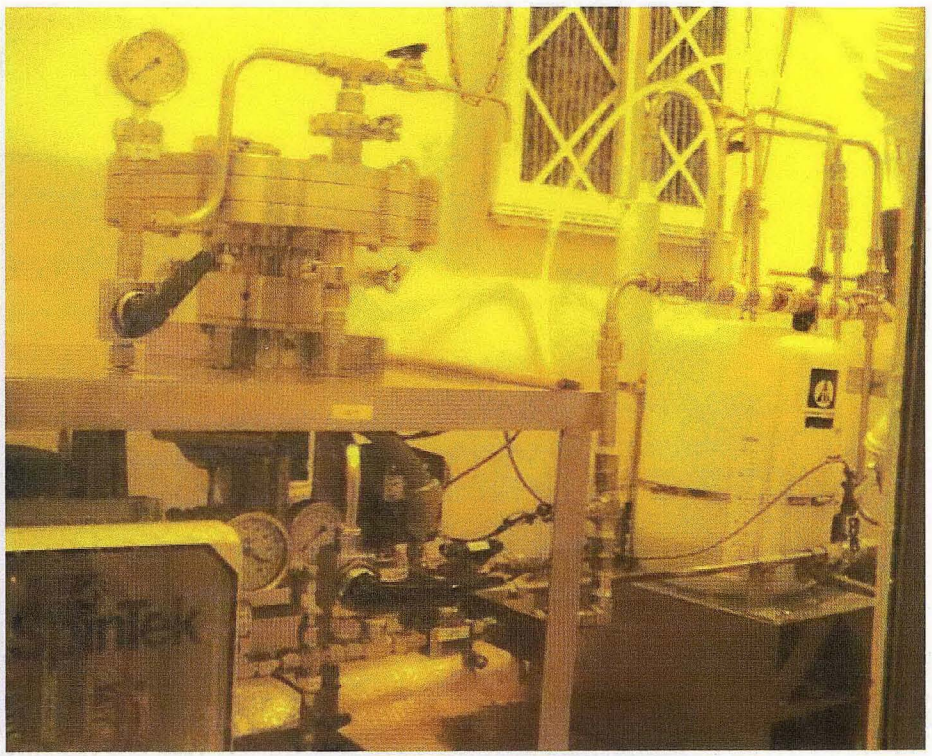


# Actual waste testing using SpinTek microfilter

## Setup of the SpinTek rotary microfilter in 1-F hot cell

- The unit was prepared in a cold test part of 222-S and then transferred to 1-F
- Support unit is mounted on a separate skid and quick-connected to filter unit
- Used two stainless steel filter disks with 0.1 and 0.5-μm nominal pore size



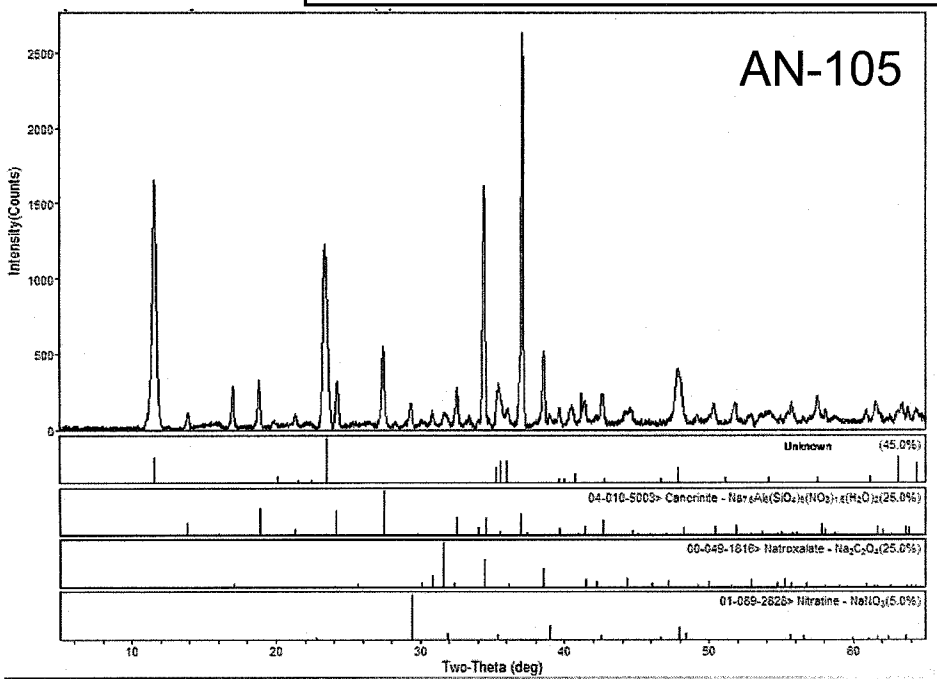



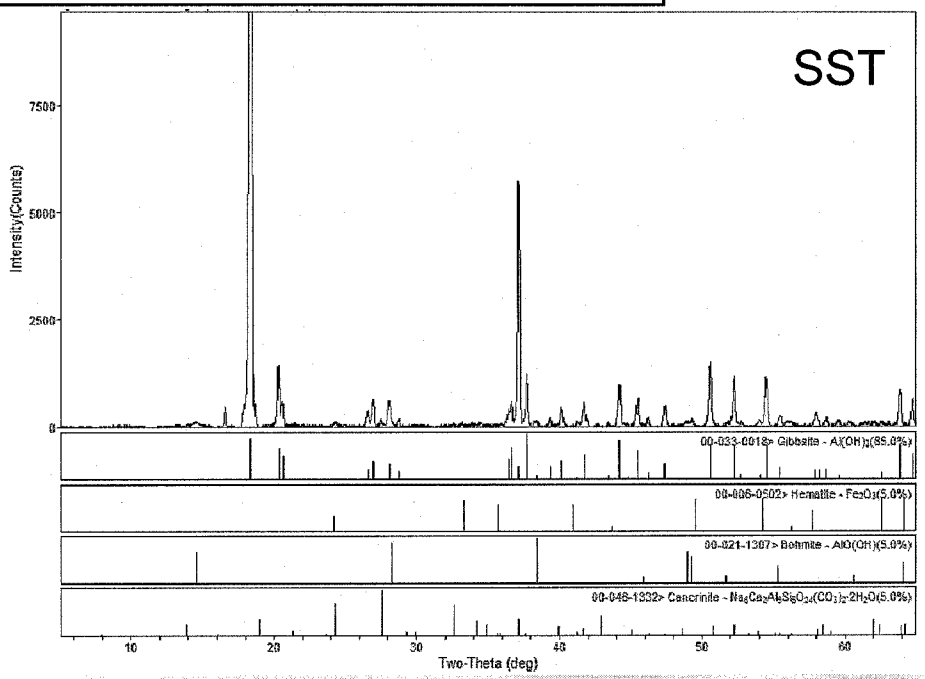
# Actual tank waste composition comparison

| | 241-AN-105 | | | | SST (composite of S and SX farms) | | | |
|---|---|---|---|---|---|---|---|---|
| | Liquid | | Solids | | Liquid | | Solids | |
| | µg/mL | mol/L | µg/g | mol/kg | µg/mL | mol/L | µg/g | mol/kg |
| Aluminum | 19800 | 0.73 | 36000 | 1.33 | 23000 | 0.85 | 181000 | 6.70 |
| Calcium | <50.5 | | 3210 | 0.08 | <50.5 | | <943 | |
| Chromium | 176 | 0.003 | 17200 | 0.33 | 4490 | 0.09 | 14100 | 0.27 |
| Iron | <5.05 | | 2550 | 0.05 | <5.05 | | 6170 | 0.11 |
| Potassium | 3640 | 0.09 | n.d. | - | 2170 | 0.06 | n.d. | - |
| Sodium | 170000 | 7.39 | 128000 | 5.57 | 189000 | 8.22 | 15200 | 0.66 |
| Silicon | 198 | 0.004 | 11100 | 0.22 | 176 | 0.003 | 5010 | 0.10 |
| Uranium | <0.10 | - | <0.005 | - | <0.10 | - | 2410 | 0.01 |
| Zirconium | <0.005 | - | <251 | - | <0.005 | - | 1920 | 0.02 |
| Fluoride | 730 | 0.04 | - | - | 35.1 | 0.002 | - | - |
| Chloride | 5440 | 0.15 | - | - | 7000 | 0.20 | - | - |
| Nitrite | 55900 | 1.22 | - | - | 68300 | 1.48 | - | - |
| Nitrate | 135000 | 2.18 | - | - | 169000 | 2.73 | - | - |
| Phosphate | 884 | 0.01 | - | - | 2720 | 0.03 | - | - |
| Sulfate | 3920 | 0.04 | - | - | 3360 | 0.04 | - | - |
| Oxalate | 464 | 0.01 | - | - | 266 | 0.003 | - | - |
| Hydroxide | 35800 | 2.11 | n.d. | - | 39900 | 2.35 | n.d. | - |
| TOC | 847 | 0.07 | 10800 | 0.90 | 1540 | 0.13 | 312 | 0.03 |
| TIC | 6470 | 0.54 | 7180 | 0.60 | 4300 | 0.36 | 382 | 0.03 |

# Actual tank waste solids comparison

| Mineral | Formula | AN-105 (%) | SST (%) |
|---|---|---|---|
| Cancrinite | Na-Ca-Al-Si-carbonate | 25 | 5 |
| Natroxalate | Na2C2O4 | 25 | - |
| Gibbsite | $Al(OH)_3$ | - | 85 |
| Hematite | $Fe_2O_3$ | - | 5 |
| Boehmite | AlO(OH) | - | 5 |
| unknown | ? | 45 | - |
| Nitratine | $NaNO_3$ | 5 | - |



# Actual waste testing using SpinTek microfilter

## Schedule of Slurries and Disks

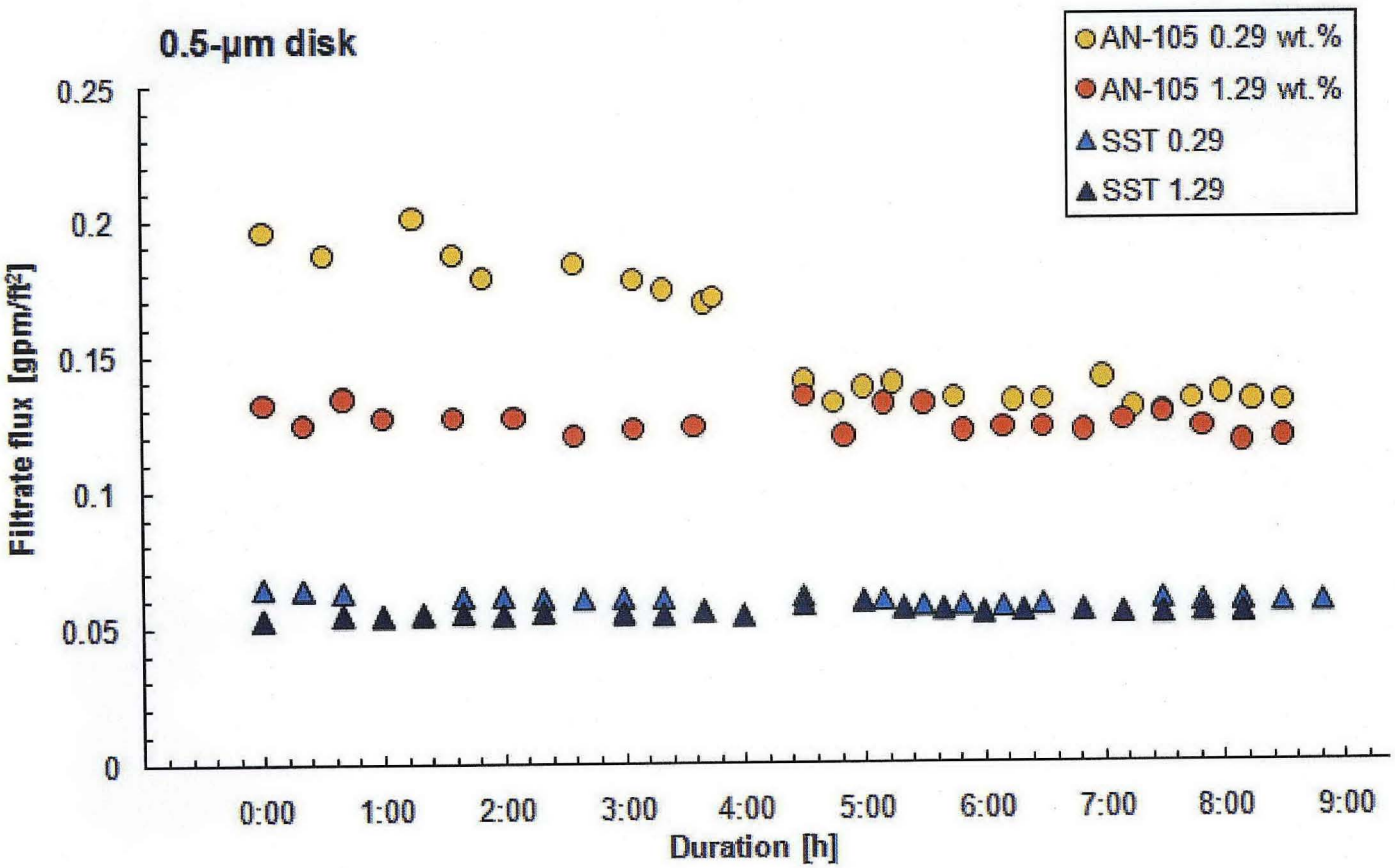
(all runs with 40 psi transmembrane pressure)

| Slurry | Disk | Comments |
|---|---|---|
| AN-105 supernate | 0.5 μm | - |
| AN-105 0.29 wt% | 0.5 μm | Actual and duplicate test runs |
| AN-105 1.29 wt% | 0.5 μm | Actual and duplicate test runs |
| AN-105 1.29 wt% | 0.1 μm | Actual, partial, and duplicate test runs |
| SST supernate | 0.5 μm | - |
| SST 0.29 wt% | 0.5 μm | Actual and duplicate test runs |
| SST 1.29 wt% | 0.5 μm | Actual and duplicate test runs |
| SST 1.29 wt% | 0.5 μm | Concentrating run |
| SST sim 1.29 wt% | 0.5 μm | Actual test run |
| AN-105 sim 1.29 wt% | 0.5 μm | Actual and duplicate test runs |
| AN-105 1.29 wt% | 0.5 μm | Actual and duplicate test runs |

# Actual waste results using SpinTek microfilter

## Filtrate Flux of AN-105 and SST actual slurries

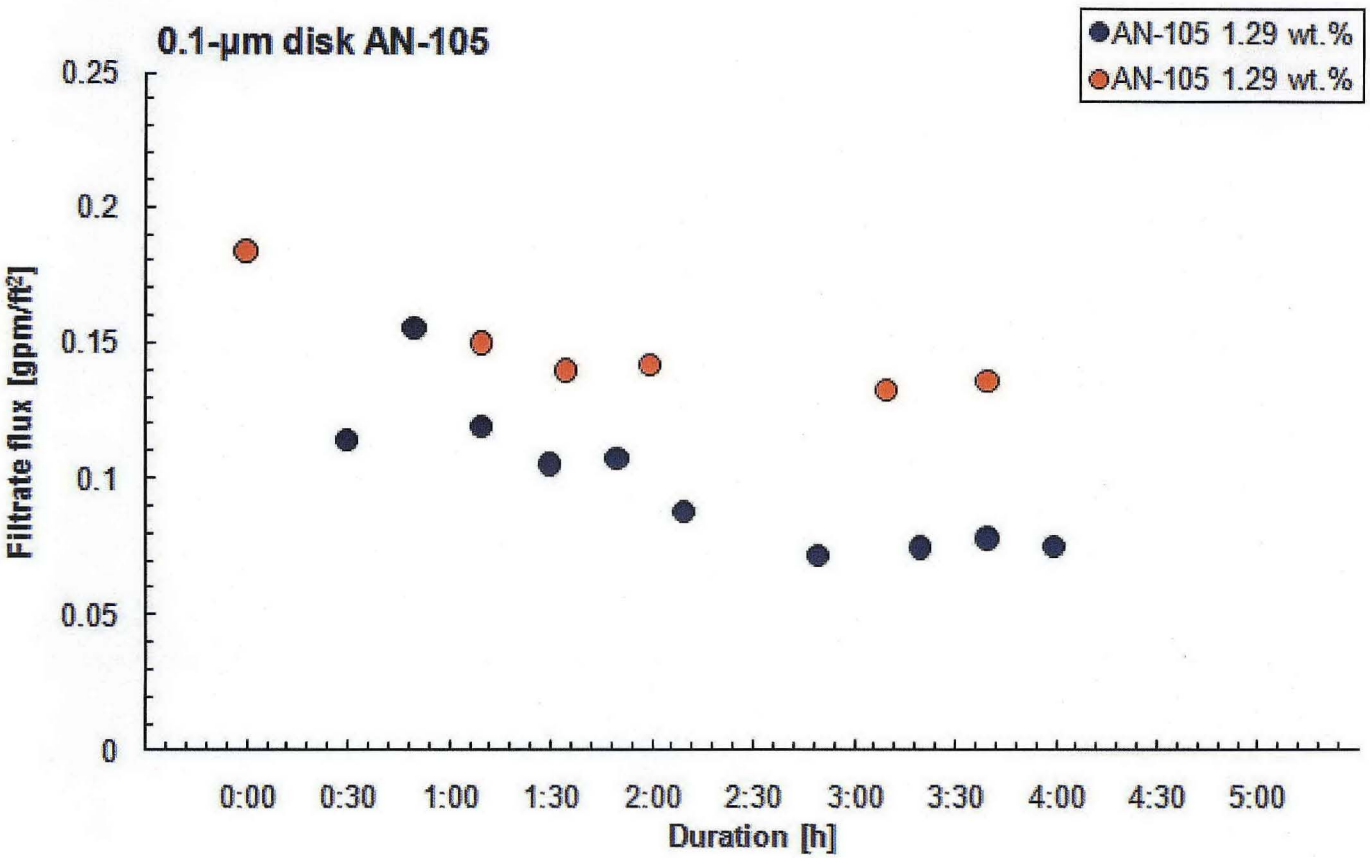
(corr. to 35°C; 40 psi transmembrane pressure)



# Actual waste results using SpinTek microfilter

## Filtrate Flux of AN-105 actual slurry

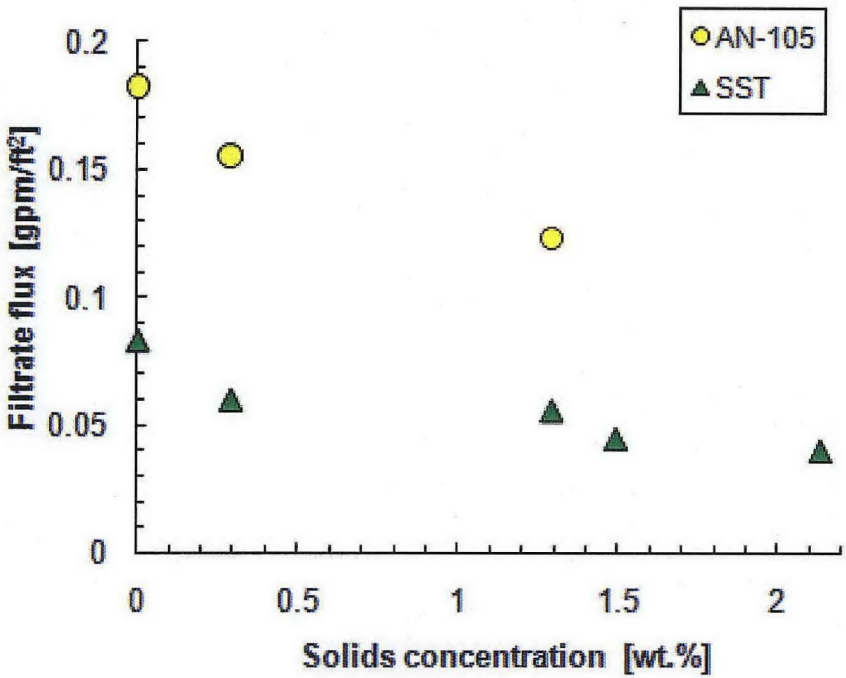
(corr. to 35°C ; 40 psi transmembrane pressure)



# Actual waste results using SpinTek microfilter

## Influence of Solids Loading on Filtrate Flux

(corr. to 35°C ; 40 psi transmembrane pressure)




The maximum concentration of 2.7 wt.% was limited by the actual amount of solids present and the minimum amount of liquid necessary to run the system as it was designed for these experiments (theoretical max. was 4.0 wt.%). SRNL presented data of an 11.7 wt.% actual tank slurry in WSRC-TR-2003-00030.

# Actual waste results using SpinTek microfilter

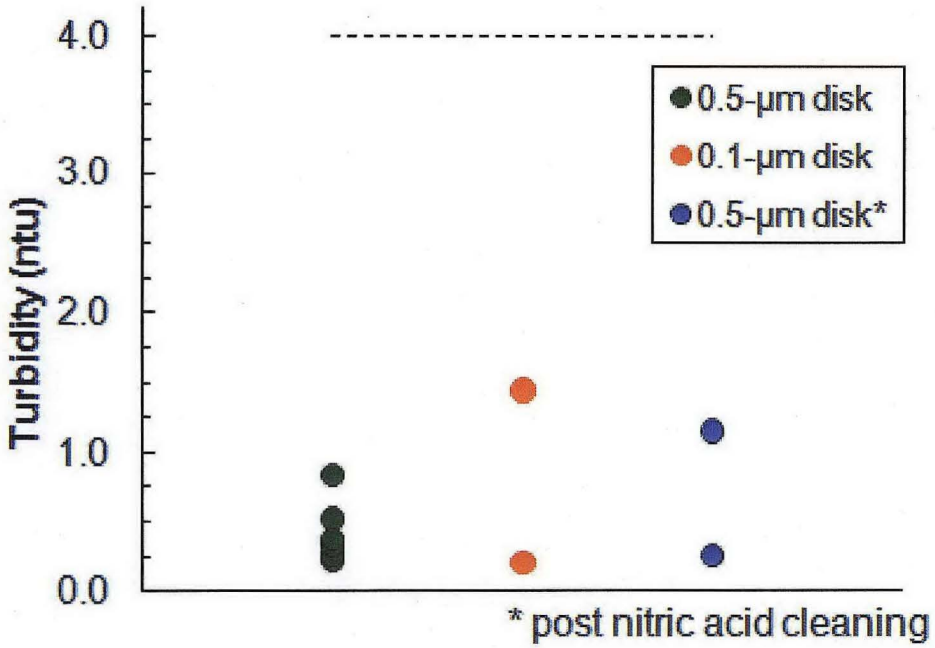
## Comparison of actual and simulant filtrate fluxes

| Ave. stable filtrate flux at 35°C | 0.5-µm disk [gpm/ft²] | 0.1-µm disk [gpm/ft²] | 0.5-µm cleaned [gpm/ft²] | Solids [wt.%] |
|---|---|---|---|---|
| AN-105 supernate | 0.18 | | | 0 |
| AN-105 0.29 wt.% | 0.16 | | | 0.29 |
| AN-105 1.29 wt.% | 0.12 | 0.11 | 0.29 | 1.29 |
| AN-105 sim 1-F | | | 0.40 | 1.29 |
| SST supernate | 0.083 | | | 0 |
| SST 0.29 wt.% | 0.060 | | | 0.29 |
| SST 1.29 wt.% | 0.055 | | | 1.29 |
| SST conc | 0.044 | | | 1.49 |
| SST conc | 0.039 | | | 2.13 |
| SST sim 1-F | 0.037 | | | 1.29 |
| AN-105 sim cold test | 0.49 | | | 0.29 |
| SST sim cold test | 0.22 | 0.22 | | 0.29 |
| AN-105 sim cold test | 0.46 | 0.34 | | 1.29 |
| SST sim cold test | 0.14 | 0.19 | | 1.29 |

# Actual waste testing using SpinTek microfilter

## Filtrate clarity

All turbidity measurement results were below the required <4 ntu.



# Actual waste testing using SpinTek microfilter

## Disk Fouling due to inactivity

After 3 months in water, the disk shows dark streaks and a highly reduced filtrate flux

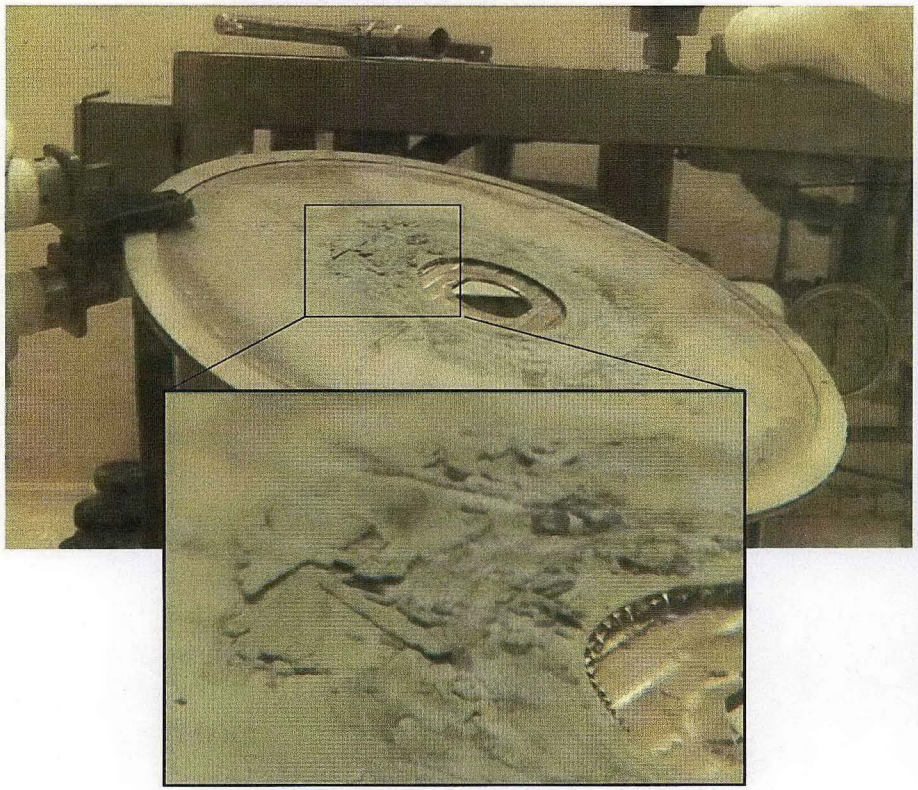
Left: 0.1-µm disk as retrieved from the filter housing

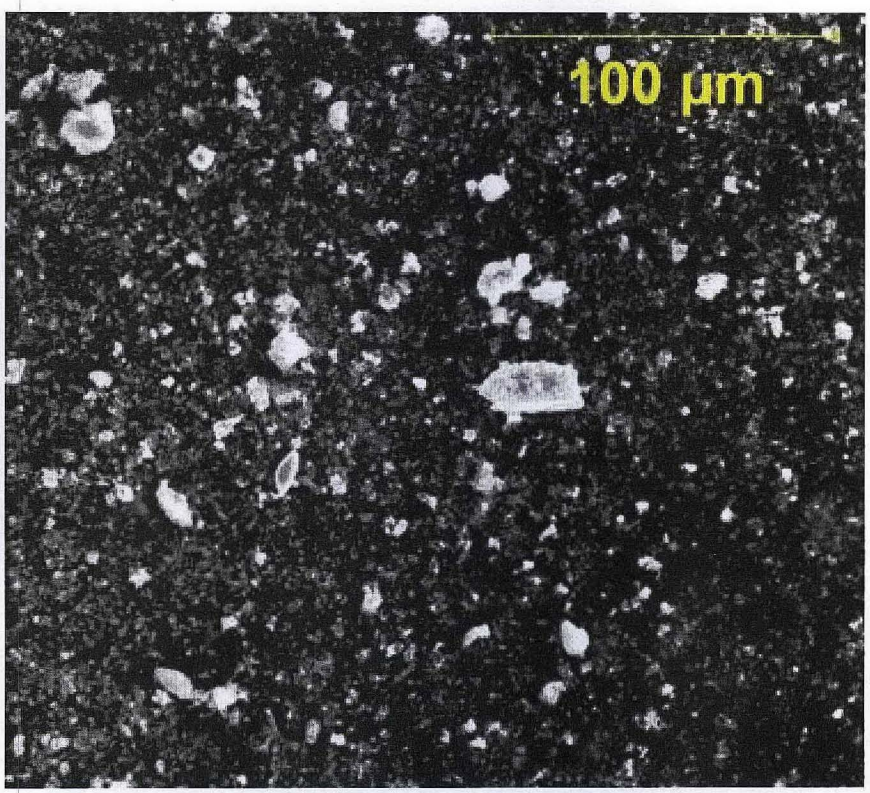
Right: clean 0.5-µm disk

# Actual waste testing using SpinTek microfilter

## Disk Fouling during operation

The 0.1-µm disk showed serious pressure fluctuations → after removal of the disk material flaked off over night.



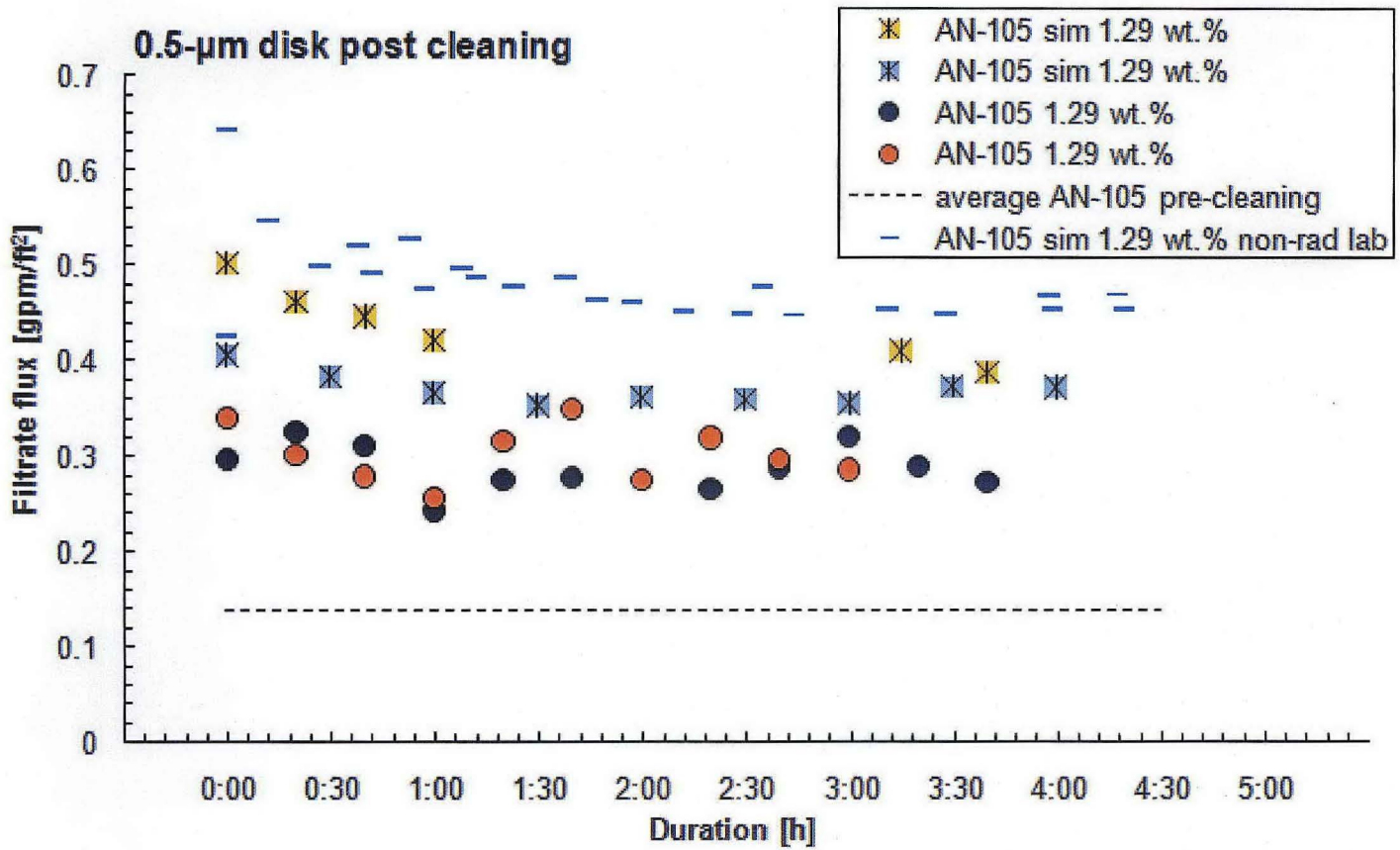



SEM-EDS analyses showed that the material flaking off the disk was mostly made of <5 µm Na-Al silicates, Al-rich (+Cr), Ni-rich, U-rich and $Ca_3(PO_4)_2$-particulates.

# Actual waste testing using SpinTek microfilter

## Disk Fouling during operation 2

The 0.5-μm disk also showed serious pressure fluctuations during AN-105 actual waste tests → Cleaning with 1M nitric acid restored filtrate flux to 90 %.



# Actual waste testing using SpinTek microfilter

## Summary and Outlook

I. Actual tank waste from Hanford tanks show lower filtrate flux by 0.3-0.6x.

II. Disk fouling during operation can be approached by running the system with 1 M nitric acid. This restores the filtrate flux to ~ 0.9x of original flux.

III. 0.1-μm disk has no apparent advantage over 0.5-μm disk; same filtrate clarity, but lower flux rates => not recommended for Hanford tank waste

**The single disk model of the SpinTek filtration unit in 1-F of the 222-S laboratory is ready for any future tests.**

**(e.g., new filter materials or different feed slurries)**

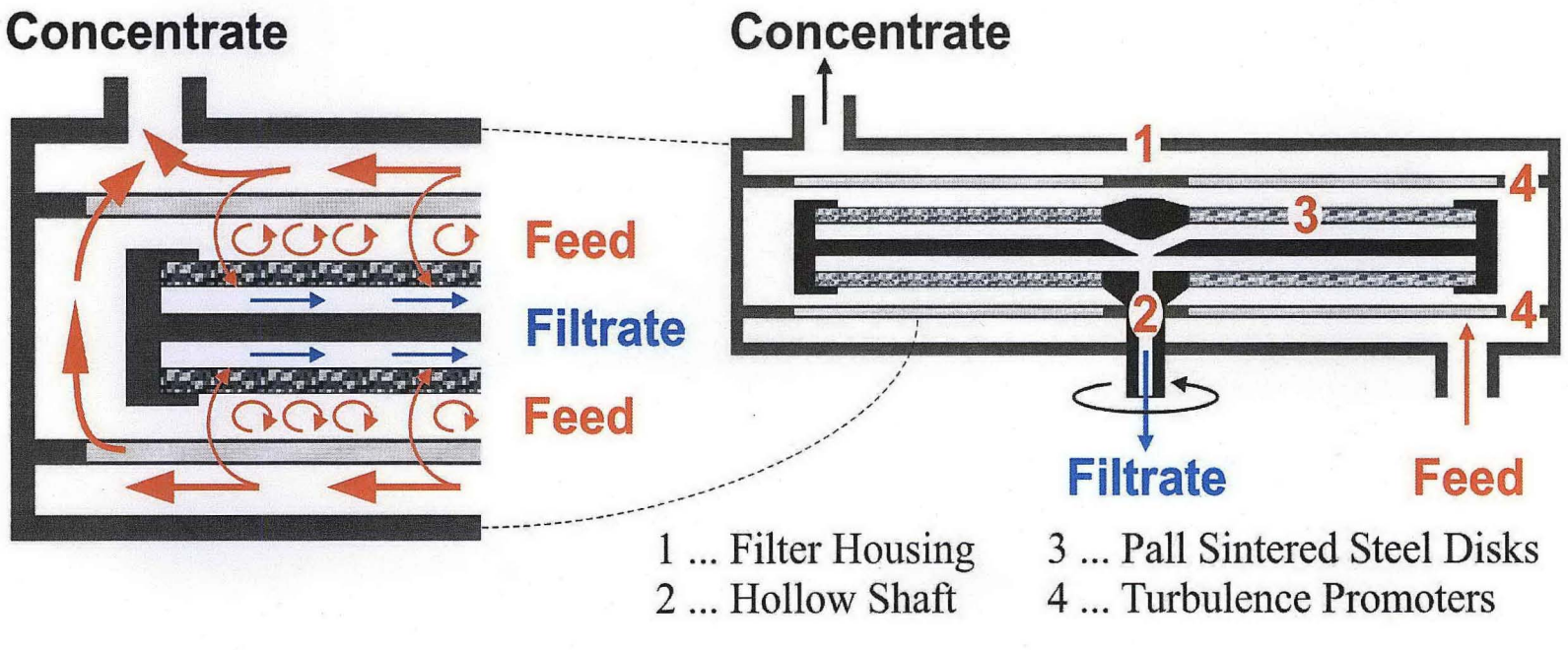
**Thank you for your attention!**

# Actual waste testing using SpinTek microfilter

## Principle of Filtration in the SpinTek system

(backup slide)

Promoters, shaped like wagon wheels, induce the turbulence needed to prevent rotational flow → reduced filter fouling



# Actual waste testing using SpinTek microfilter

## Calculation of temperature adjusted filtrate fluxes

(backup slide)

For better comparison between the different test groups, all filtrate fluxes were corrected to 35 °C (= 95 °F = 308.15 K). Temperature corrected fluxes were calculated using the equation:

$$F_{35C} = F_{original\_flux} \cdot e^{2500\left(\frac{1}{T+273.15} - \frac{1}{308.15}\right)}$$

(see INEEL/EXT-04-01933, *Alternative Ultrafiltration Membrane Testing for the SRS Baseline Process.*)

# Actual waste testing using SpinTek microfilter

## Results of single disk model at SRNL

(backup slide; from SRNL-STI-2009-00330)